Nutrient Criteria Development Process for Streams

The Surface Water Quality Bureau (SWQB) is in the process of developing numeric nutrient criteria. Nutrient criteria development for streams in New Mexico has taken place in three steps, thus far. First, the EPA compiled nutrient data from the national nutrient dataset, divided it by waterbody type, grouped it into nutrient ecoregions, and calculated the 25th percentiles for each aggregate and Level III ecoregion (**Table 1**). EPA published the recommended water quality criteria for Total Nitrogen (TN) and Total Phosphorus (TP) to help states and tribes reduce problems associated with excess nutrients in waterbodies in specific areas of the country (USEPA 2000). Refinement of the recommended draft ecoregional nutrient criteria was conducted by Evan Hornig, a USGS employee assisting states in EPA Region 6 with development of nutrient criteria. Hornig used regional nutrient data from EPA's Storage and Retrieval System (STORET), the U.S. Geological Survey (USGS), and the Surface Water Quality Bureau (SWQB) to create a regional dataset for New Mexico. The revised threshold values were calculated based on EPA procedures and the median for each Level III ecoregion (**Table 2**).

The third round of analysis was conducted by SWQB to produce nutrient threshold values for streams based on ecoregion and designated aquatic life use. For this analysis, TP, total Kjeldahl nitrogen (TKN), and nitrate plus nitrite (N+N) data from the National Nutrient Dataset (1990-1997) was combined with Archival STORET data for 1998, and 1999-2006 data from the SWQB in-house database. The process that SWQB used for this analysis is detailed below.

The query tool was used to acquire nutrient data from rivers and streams in the National Nutrient Dataset. There were 3230 total phosphorus, 3450 total Kjeldahl nitrogen, and 3250 nitrate plus nitrite stream data points generated with this query. The site information associated with the nutrient data such as the latitude and longitude, sample date, and water body name were include in the query. The query also contained a "Standard Value" which had one half of the "Reported Value" for those data points that were below the detection limit.

Data from 1998 was acquired from Archival STORET using the Advance Query Tool, and downloading all of the surface water data between 01-01-1998 and 12-30-1998 for parameter codes 00665 (Total Phosphorus), 00625 (Total Kjeldahl Nitrogen), and 00630 (Nitrate plus Nitrite). Unfortunately, the entire state could not be queried for specific dates and parameters so the data had to be downloaded by each county separately. Data for rivers, lakes, and reservoirs as well as playas was removed from this dataset. This query generated 483 total phosphorus, 489 total Kjeldahl nitrogen, and 662 nitrate plus nitrite data points. The "Standard Value" was calculated and these data were appended to the pre-1998 data.

Data from 1999 to 2006 were acquired from the SWQB in-house database. A query was run to compile total phosphorus, total Kjeldahl nitrogen, and nitrate plus nitrite data from streams as well as sample date and site location information. This query generated 3125 total phosphorus, 3216 total Kjeldahl nitrogen, and 3223 Nitrate plus Nitrite data points. The "Standard Value" was calculated and these data were appended to the pre-1999 data. All of the "Units" and "Standard Units" were converted to mg/L and designations for below the detection limit were standardized between the datasets from the different sources.

Once the dataset was compiled, the data were divided by waterbody type, removing all rivers, reservoirs, lakes, wastewater treatment effluent, and playas. For this project "rivers" were defined as systems that cannot be monitored effectively with methods developed for wadeable streams and generally have drainage areas greater than 2,300 square miles. The systems included in the "rivers" waterbody type are: 1) the San Juan River from below Navajo Reservoir to the Colorado border near Four Corners, 2) the Rio Grande in New Mexico, 3) the Pecos River from below Sumner Reservoir to the Texas border, 4) the Rio Chama from below El Vado Reservoir to the Rio Grande, 5) the Canadian River below the Cimarron River , 6) Rio Puerco below the confluence with the Rio San Jose, and 7) the Gila River below Mogollon. GIS was used to identify data from river sites as defined above.

Level III and IV Omernik ecoregions (Omernik 2006) as well as the designated aquatic life use were assigned to all stream sites using GIS coverages and the station's latitude and longitude. New Mexico has 7 aquatic life uses: high quality coldwater, coldwater, marginal coldwater, warmwater, marginal warmwater, aquatic life, and limited aquatic life. Aquatic life and limited aquatic life sites were not used in this analysis as they generally represent waters with ephemeral or intermittent flow, naturally occurring rapid environmental changes, high turbidity, fluctuating temperatures, low dissolved oxygen content or unique chemical characteristics. Data from sites that had aquatic life designations of "aquatic life use" or "limited aquatic life use" were removed from the dataset. The 5 other aquatic life uses were divided into 3 groups:

1. Coldwater (CW) – those segments having only coldwater uses (high quality coldwater or coldwater)
2. Transitional (T)– waterbodies with marginal coldwater or both cold and warmwater uses
3. Warmwater (WW) - waterbodies having only warmwater uses (warmwater or marginal warmwater)

Because of the limited area and number of sites in the Madrean Archipelago (79), Western High Plains (25), and Colorado Plateau (20) ecoregions, these data where grouped with the most similar ecoregions; the Madrean Archipelago with the Chihahuan Desert and the Colorado Plateau with the Arizona New Mexico Plateau. The Western High Plains had no stream data as the only surface waters are playas, therefore this ecoregion was not included in the analysis.

The stream data were divided first by ecoregion then by aquatic life use. In ecoregion 26 on the Gallinas River below San Augustin, there was a period of 3 days when 4 to 15 samples were collected. For these data, daily averages were calculated. When there were less that 60 data points in the warmwater group, these data were combined with the transitional group to form the Trans/WW group. The 50^{th} percentiles (medians) were calculated for each parameter and ecoregion/aquatic life use group using Excel. The total nitrogen value was then calculated by adding the percentile for total Kjeldahl nitrogen with the percentile for nitrate plus nitrite. The threshold values generated during the third round of analysis will be incorporated into the SWQB Stream Nutrient Assessment Protocol and are shown in **Table 3**.

There was no difference in the TP threshold values for the coldwater and trans/ww groups in ecoregion 21. However, when examining the different level IV ecoregions there was a significant difference in the TP data from the volcanic and the other groups. This lead to the development of a separate threshold value for the ecoregion 21 volcanic group. The threshold

value was calculating by determining the median of the data from ecoregions 21g and 21h as well as 21j in the Jemez Mountains. The Grassland Parks (21j) of the Jemez Mountains were included in this group as they are of volcanic origin and have the characteristic higher background TP.

A fairly large portion of the data was censored, i.e. below the detection limit (15-67% for TP, 10-86% for N+N, and 6-38% for TKN). For comparison purposes, percentiles were calculated in two ways; using the substitution method (one half the detection limit) in Excel and using the nonparametric Kaplan-Meier method in Minitab®. In cases where the proportion of censored data was too high for Kaplan-Meier analysis, Regression on Order Statistics (ROS) was used. Interestingly, the results from the different analyses produced very similar results (**Table 4**). However, this analysis was conducted on an incomplete dataset. The final threshold values that will be incorporated into the SWQB Stream Nutrient Assessment Protocol were generated with the complete dataset using the substitution method given that the substitution and Kaplan-Meier methods produced similar results.

Table 1. Draft Ecoregion Nutrient Targets for streams (mg/L), calculated using **25th percentile** by EPA procedures draft Ecoregion Nutrient Criteria (EPA 2000)

	21-Southern Rockies	23-AZ/NM Mountains	22-AZ/NM Plateau	24-Chihuahuan Desert	26-SW Tablelands
TN	0.04	0.12	0.085	0.543	0.26
TP	0.006	0.011	0.015	0.018	0.025

Table 2. Ecoregion Nutrient Targets for streams (mg/L), calculated using regional data, the **50th percentile** and EPA procedures (USGS, unpublished data 2003)

	21-Southern Rockies	23-AZ/NM Mountains	22-AZ/NM Plateau	24-Chihuahuan Desert	26-SW Tablelands
TN	0.30	0.32	0.42	0.64	0.54
TP	0.025	0.020	0.070	0.062	0.025

Table 3. Ecoregion Nutrient and Aquatic Life Use Targets for streams (mg/L), using regional data and the **50th percentile** (SWQB 2007).

	21-Southern Rockies		22-AZ/NM Plateau		23-AZ/NM Mountains		24-Chihuahuan Desert	26-SW Tablelands		
TN	0.25		0.35		0.25		0.53	0.38		
TP	0.02		0.05		0.02		0.04	0.03		
ALU	CW	T/WW (volcanic)	CW	T/WW	CW	T/WW	T/WW	CW	T	WW
TN	0.25	0.25	0.28	0.48	0.25	0.29	0.53	0.25	0.38	0.45
TP	0.02	0.02 (0.05)	0.04	0.09	0.02	0.05	0.04	0.02	0.03	0.03

Table 4. Comparison of the percentiles (mg/L), calculated using the substitution (substitut.) and Kaplan-Meier and methods. The proportion of the data that was below the detection limit is show in the % < DL columns.

Total Phosphorus

Phos_Group	n	25th	50th	%< DL
21-substitut.	2160	0.015	0.020	41
21-Kap-Meier		*	0.020	
22-substitut.	320	0.020	0.040	19
22-Kap-Meier		0.020	0.040	
23- substitut.	855	0.020	0.020	49
23-Kap-Meier		0.003	0.020	
24- substitut.	149	0.040	0.070	7
24-Kap-Meier		0.040	0.070	
26- substitut.	502	0.010	0.020	42
26-Kap-Meier	428	*	0.020	45

Total Kjeldahl Nitrogen

TKN group	n	25th	50th	%<DL
21- substitut.	2167	0.100	0.200	24
21-Kap-Meier		0.100	0.200	
22- substitut.	399	0.115	0.330	22
22-Kap-Meier		0.130	0.330	
23- substitut.	864	0.110	0.200	19
23-Kap-Meier		0.120	0.200	
24- substitut.	140	0.100	0.250	34
24-Kap-Meier		*	0.270	
26- substitut.	494	0.158	0.325	18
26-Kap-Meier		0.160	0.316	

Nitrate plus Nitrite

N + N group	n	25th	50th	%<DL
21- substitut.	2217	0.025	0.050	60
21-Kap-Meier		*	0.040	
22- substitut.	236	0.050	0.140	30
22-Kap-Meier		*	0.140	
23- substitut.	829	0.025	0.050	57
23-Kap-Meier		0.019**	0.05**	
24- substitut.	132	0.160	0.300	4
24-Kap-Meier	129	0.160	0.300	
26- substitut.	415	0.050	0.090	36
26-Kap-Meier	414	0.040	0.090	

References

United States Environmental Protection Agency (EPA). 2000. Nutrient Criteria Technical Guidance Manual: Rivers and Streams. EPA-822-B-00-002. http://www.epa.gov/ost/criteria/nutrient/guidance/rivers/index.html

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